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SEED QUALITY AS INFLUENCED BY DORMANCY BREAKING TREATMENTS IN FOXTAIL MILLET GENOTYPES

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ABSTRACT

A lab investigation was carried out with 9 genotypes of foxtail millet to fix the best dormancy breaking treatment based on the seed quality of the treated seeds. Seeds were subjected to various physico chemical treatments viz., control, exposure to sun light for 48 hr, exposure to 45 °C for 24 hr and 48 hr, water soaking for 12 and 24 hr, soaking in KNO_3 at 0.5 and 1 per cent, soaking in HNO_3 at 0.5 and 1 per cent, soaking in ethrel at 25 and 50 ppm, hot water treatment at 50 °C and 60 °C for 1 min and soaking in Thiourea at 0.5 and 1 per cent. Among the treatments, ethrel at 25 ppm followed by pre-heat treatment for 48 hr was most effective in release of dormancy in foxtail millet genotypes. Seeds treated with ethrel at 25 ppm recorded highest seed germination (86.44 %), seedling length (23.35 cm), dry matter (29.41 mg) and lowest electrical conductivity (0. 314 dSm^{-1}).

KEYWORDS: Foxtail Millet, Dormancy, Ethrel, Germination

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INTRODUCTION

Unlike the yester years a lot of discussions are going on about the climate smart group of crops, “millets”. It is mainly because of the health consciousness of people as well as its resilience towards changing climatic conditions. Foxtail millet (S*etaria italica* L.) one among the six small millets is cultivated in India, China, Eastern Europe, Southern parts of USSR and to some extent in African and American countries for hay, pasture and food grain. Foxtail millet is also known as *navane, kangni, tenai, korra* and *rala* in various Indian languages. It was once an indispensable crop of vast rainfed areas in semi- arid regions in India. In our country, it is cultivated in Karnataka, Andhra Pradesh, Madhya Pradesh and Uttar Pradesh. Dormancy is a major bottle neck in its cultivation which is not much addressed. Foxtail millet is generally sown as a mixed crop with cotton, maize, *arhar* and black gram. Only sometimes, it is raised as a pure crop. When it is grown as a pure crop, it can be rotated with linseed, gram, barley and pea. As a result of delay in germination, the harvesting time also varies and affects the crop rotation. If ethrel is applied at higher dose or seeds are at an advanced state of after-ripening, then an inhibition in germination is seen or they would not give rise to healthy seedlings (Stephen Adkins and James Ross, 1981). Suryawanshi *et al*. (1989) observed enhanced germination in pearl millet after storing the seeds for 8 days at 30 °C and 40 to 50 per cent RH. The present investigation was taken up with the objective of finding out various methods to break dormancy of foxtail millet genotypes.

MATERIALS AND METHODS

The experiment was conducted at Department of Seed Science and Techology, UAS, Raichur using the seed material obtained from Agricultural Research Station, Hanumanamatti, University of Agricultural Sciences, Dharwad. Nine genotypes *viz.,* DHFt-4-5, DHFt-35-1, DHFt-55-3, DHFt-2-3, DHFt-109-3, DHFt-2-5, DHFt-2-5-1, DHFt-5-3 and Sia-326 (C) were subjected to various physical and chemical dormancy breaking treatments *viz.*, control, exposure to sun light for 48 hr, exposure to 45 °C for 24 hr and 48 hr, water soaking for 12 and 24 hr, soaking in KNO_3 at 0.5 and 1 per cent, soaking in HNO_3 at 0.5 and 1 per cent, soaking in ethrel at 25 and 50 ppm, hot water treatment at 50 °C and 60 °C for 1 min and soaking in Thiourea at 0.5 and 1 per cent. For the chemical treatments, soaking duration was 8 hr and the standard germination test was conducted thereafter.

Top of paper method of germination test as prescribed by ISTA (1996) was followed. Four replications of 100 seeds each were randomly counted and placed on the blotter paper at uniform spacing in circular manner in petri dish. Then petri dish was covered with lid and placed in cabinet of seed germinator by maintaining a constant temperature of 25 ± 1 °C and relative humidity of 90%. The germination was recorded on 7th day and based on normal seedlings produced; the germination percentage was worked out. The seedling length was measured from tip of shoot to root tip of normal seedlings and the mean length was calculated and expressed as seedling length in centimeter. Ten randomly selected seedlings for measuring seedling length obtained after final count were dried at 70 ± 1 °C for 24 hr in hot air oven and dry weight in milligram was determined by weighing them on an electronic balance.

Five grams of seeds in three replications were soaked in acetone for half a minute and thoroughly washed in distilled water for three times. Then the seeds were soaked in 25 ml distilled water and kept in an incubator maintained at 25 °C ±1 for twelve hr. The seed leachate was collected and the volume was made up to 25 ml by adding distilled water. The electrical conductivity of the seed leachate was measured in the digital conductivity bridge (WENSAR) with a cell constant 1.0 and the mean values were expressed in decisiemens per meter (dSm^{-1}) (Jackson, 1973).

RESULTS

A significant variation was observed among the genotypes, treatments and their interaction for germination percentage. Among the genotypes, DHFt-35-1 recorded maximum germination (76.29%) and it was on par with DHFt-2-5 (75.79%), whereas minimum (70.31%) was observed in DHFt-5-3 followed by DHFt-4-5 (72.06%) (Table1). The ethrel treatment at 25 ppm showed significantly the highest mean germination (86.44%) followed by heat treatment at 45 °C for 48 hr (84.74%), and KNO_3 at 0.5 per cent (83.33%) while, control recorded the least germination of 38.07 per cent.

The data indicated that there was a significant variation among the genotypes and treatments for seedling length (Table 2). Significantly higher seedling length was recorded in seeds treated with ethrel at 25 ppm (23.35 cm) followed by heat treatment for 48 hr at 45 °C (21.79 cm) and lower seedling length was observed in control (12.71 cm) irrespective of the genotypes. Among the nine genotypes maximum mean seedling length was recorded in DHFt-35-1 (19.65 cm) followed by Sia-326 (C) (18.36 cm) and significantly lowest seedling length was recorded in DHFt-5-3 (15.80 cm).

Among the genotypes, DHFt-35-1 recorded highest seedling dry matter (24.31 mg) (Table 3) and it was on par with DHFt-2-5-1, DHFt-109-3 and DHFt-2-5 (24.21, 23.92 and 23.65 mg respectively) whereas, lowest (22.73 mg) was

recorded in DHFt-5-3. Among all the treatments ethrel at 25 ppm revealed the maximum seedling dry matter (29.41 mg) followed by heat treatment at 45 °C for 48 hr (28.30 mg). The control recorded minimum seedling dry matter (17.59 mg).

The maximum electrical conductivity (dSm^{-1}) was observed in DHFt-5-3 (0.553) followed by DHFt-4-5 (0.501), while lowest value of electrical conductivity was observed in DHFt-2-5-1 (0.408) and results were on par with DHFt-35-1 (0.414) (Table 4). Among all the treatments highest value was recorded in HNO_3 at 1 per cent (0.669) followed by HNO_3 at 0.5 per cent (0.587) and control (0.557), lowest value was observed in ethrel treatment at 25 ppm (0.314) and it was on par with heat treatment for 48 hr at 45 °C (0.321).

DISCUSSIONS

All the seed quality parameters were higher in ethrel treatment at 25 ppm compared to control. These results indicate that ethrel may be a more effective dormancy breaking agent. Similar results have been reported by (Singh and Rao, 1994; Gerald Seiler, 1998; Borghetti *et al.*, 2002 and Fabian *et al.*, 2002) opined that the protease activity might be involved in breaking dormancy by ethylene and there by improvement in germination of embryo was seen. Coffelt and Howell (1986) reported that stand counts and plant dry weight increased in ethrel seed treatment. Earlier studies suggested that ethylene may enhance vigour of some seeds and stimulate metabolism of seeds.

The increased germination in dry heat treatments could be due to the denaturation of inhibitors and also enhanced after-ripening process. The enhanced germination by heat treatment confirms the earlier finding of Kota Janaiah *et al.* (2006) and Abdul Waheed *et al.* (2012) in rice cultivars. This increased germination due to heat treatment possibly helped in overcoming the restriction of availability of oxygen to the embryo by increasing cracks in the seed coat or reducing the peroxidase activity in the seed covering structures thereby promoting the degradation and evaporation of short chain saturated fatty acids (SCSFAs) from the dormant seeds thereby increasing the germinability.

Since, germination has improved to above Seed Certification Standard (75%) in the treatments *viz.*, thiourea at 1 per cent, KNO_3 treatment at 0.5 per cent, water soaking for 24 hr, hot water treatment at 50 °C for 1 min and exposing the seeds to sunlight for 48 hr, which can be recommended for the weakly and moderate dormant genotypes. Thiourea substitutes for light and it enhances germination (Mayer and Poljakoff-Mayer, 1963).

Even though ethrel treatment is effective; the cost of the chemical is higher which is disadvantageous. Heat treatment at 45 °C for 48 hr can be recommended for all the genotypes, which is a practically feasible alternative. Treatments like thiourea at 1 per cent and water soaking for 24 hr were effective but, it can be recommended only for genotypes with strong dormancy.

Seedling length and seedling dry weight are indications of increased vigour index. This shows that the seeds treated with these chemicals will also have a positive impact on the performance at field level. Kattimani *et al.* (1999) recorded highest seedling vigour, dry matter accumulation and root length in soybean seeds treated with nitrate.

Among the treatments, significantly highest electrical conductivity (dSm^{-1}) was observed in HNO_3 at 1 per cent. Similar findings were reported earlier too. Acid treatment injures the seeds since it break vital parts of the embryo (Aliero, 2004). Shanmughavalli *et al.* (2007) opined that acid scarification results in disruption of lemma and palea, which

increases the permeability of seed coat. This points out to a fact that HNO_3 treatment may be deleterious to the seed and seedlings.

CONCLUSIONS

Therefore, it can be concluded that to break the dormancy of foxtail millet, ethrel at 25 ppm can be recommended since it do not have any detrimental effects on seed quality but maintains it and enhance it as well. Early germination is required for breeder seed production. Dormancy breaking methods are beneficial to farmers as well as for malting industry. Further research is required to trace out the reasons of dormancy in millets.

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APPENDICES

Table 1: Effect of Dormancy Breaking Methods on Seed Germination (%) of Foxtail Millet Genotypes

Genotypes	Control	Treatments: Sun drying (48 hr)	Heat treatment (45 °C)		Water soaking		Hot water (1 min)		KNO_3		HNO_3		Ethrel		Thiourea		Mean
			24 hr	48 hr	12 hr	24 hr	50 °C	60 °C	0.5 %	1%	0.5 %	1%	25 ppm	50 ppm	0.5 %	1%	
DHFt-5-3	10.14	15.00	16.67	20.23	16.17	17.67	16.27	15.00	19.70	14.20	12.17	10.60	21.30	18.37	14.33	15.00	15.80
DHFt-4-5	13.06	18.27	17.80	21.43	16.00	17.57	18.67	16.00	20.17	15.00	14.30	13.50	23.67	19.80	16.27	16.23	17.36
DHFt-55-3	13.22	16.67	17.77	21.50	15.67	17.80	16.50	16.23	21.00	16.17	14.07	13.63	21.83	18.20	17.00	16.67	17.12
Sia-326 (C)	14.39	18.67	18.30	20.37	17.67	19.67	19.33	17.67	20.13	17.83	15.30	14.93	24.33	19.87	16.67	18.70	18.36
DHFt-35-1	13.83	18.67	19.27	25.27	18.17	23.17	19.00	18.00	23.83	18.00	15.13	14.67	27.33	23.47	17.67	19.00	19.65
DHFt-2-5-1	12.83	15.67	20.17	22.70	17.00	21.67	18.00	16.00	22.13	16.00	14.50	13.30	23.27	21.90	16.17	18.50	18.11
DHFt-2-3	12.07	17.60	16.50	20.57	16.00	18.37	17.67	16.67	20.10	14.07	13.90	13.10	22.00	18.83	16.47	17.67	16.97
DHFt-109-3	12.11	18.50	18.83	23.37	17.00	20.07	18.17	18.00	22.23	16.33	13.80	12.60	24.33	20.97	17.67	18.50	18.28
DHFt-2-5	12.77	16.50	17.67	20.67	15.77	18.33	17.27	17.33	19.23	15.00	14.33	13.33	22.10	18.40	15.67	17.70	**17.00**
Mean	**12.71**	**17.28**	**18.11**	**21.79**	**16.60**	**19.37**	**17.87**	**16.77**	**20.95**	**15.84**	**14.17**	**13.30**	**23.35**	**19.98**	**16.43**	**17.55**	

Table 2

	S. Em±	CD at 1%
Genotype	0.211	0.586
Treatment	0.281	0.781
Interaction	0.842	NS

Table 3: Effect of Dormancy Breaking Methods on Seedling dry Matter (mg) of Foxtail Millet Genotypes

Genotypes	Control	Treatments: Sun drying (48 hr)	Heat treatment (45 °C)		Water soaking		Hot water (1 min)		KNO_3		HNO_3		Ethrel		Thiourea		Mean
			24 hr	48 hr	12 hr	24 hr	50 °C	60 °C	0.5 %	1%	0.5 %	1%	25 ppm	50 ppm	0.5 %	1%	
DHFt-5-3	17.33	20.67	21.67	27.67	21.67	23.67	22.67	20.33	26.33	22.33	20.33	19.67	29.33	24.67	23.00	22.33	**22.73**
DHFt-4-5	16.00	23.33	21.33	28.67	21.33	25.67	21.67	18.00	27.67	21.67	20.33	18.00	29.33	26.00	20.67	26.67	**22.90**
DHFt-55-3	16.67	21.67	16.33	28.33	26.00	26.00	24.33	20.67	27.67	24.00	21.67	19.00	28.67	27.00	24.67	24.67	**23.58**
Sia-326 (C)	17.00	21.67	22.33	28.67	22.67	26.00	24.00	21.00	27.67	22.00	21.67	19.00	30.00	26.33	22.33	24.00	**23.52**
DHFt-35-1	21.33	24.33	20.67	29.33	24.00	25.67	22.00	21.67	27.67	21.33	24.67	21.67	31.00	27.00	22.33	24.33	**24.31**
DHFt-2-5-1	17.67	26.00	23.67	28.33	22.33	27.00	22.00	23.67	27.33	23.33	22.33	20.00	29.67	27.33	22.67	24.00	**24.21**
DHFt-2-3	16.00	22.33	24.33	28.33	21.33	26.00	21.67	22.00	27.67	23.00	20.67	17.67	29.00	26.33	22.67	22.67	**23.23**
DHFt-109-3	18.00	24.33	22.67	27.33	23.33	25.33	24.67	23.33	26.67	23.67	22.00	20.00	28.67	25.33	22.67	24.67	**23.92**
DHFt-2-5	18.33	24.00	24.67	28.00	22.00	25.00	24.33	21.67	26.67	22.00	21.00	19.00	29.00	25.67	23.33	23.67	**23.65**
Mean	**17.59**	**23.15**	**21.96**	**28.30**	**22.74**	**25.59**	**23.04**	**21.37**	**27.26**	**22.59**	**21.63**	**19.33**	**29.41**	**26.19**	**22.70**	**24.11**	

Table 4

	S. Em±	CD at 1%
Genotype	0.235	0.655
Treatment	0.314	0.873
Interaction	0.941	2.620

Table 5: Effect of Dormancy Breaking Methods on Electrical Conductivity (dSm^{-1}) of Foxtail Millet Genotypes

Genotypes	Control	Treatments															Mean
		Sun drying (48 hr)	Heat treatment (45 °C)		Water soaking		Hot water (1 min)		KNO_3		HNO_3		Ethrel		Thiourea		
			24 hr	48 hr	12 hr	24 hr	50 °C	60 °C	0.5 %	1%	0.5 %	1%	25 ppm	50 ppm	0.5 %	1%	
DHFt-5-3	0.628	0.515	0.569	0.479	0.525	0.477	0.426	0.609	0.554	0.450	0.609	0.738	0.330	0.517	0.681	0.738	**0.553**
DHFt-4-5	0.555	0.449	0.549	0.320	0.523	0.437	0.704	0.603	0.436	0.317	0.651	0.704	0.325	0.651	0.433	0.354	**0.501**
DHFt-55-3	0.464	0.524	0.637	0.339	0.426	0.514	0.286	0.277	0.225	0.471	0.423	0.545	0.326	0.425	0.548	0.357	**0.424**
Sia-326 (C)	0.557	0.259	0.243	0.268	0.441	0.521	0.357	0.570	0.482	0.349	0.662	0.727	0.357	0.436	0.486	0.628	**0.459**
DHFt-35-1	0.574	0.325	0.417	0.194	0.340	0.327	0.329	0.431	0.322	0.461	0.480	0.605	0.274	0.461	0.422	0.662	**0.414**
DHFt-2-5-1	0.527	0.330	0.421	0.384	0.423	0.119	0.654	0.328	0.186	0.212	0.570	0.628	0.269	0.613	0.529	0.331	**0.408**
DHFt-2-3	0.643	0.423	0.545	0.486	0.423	0.528	0.464	0.528	0.446	0.504	0.646	0.664	0.418	0.435	0.520	0.333	**0.500**
DHFt-109-3	0.537	0.366	0.461	0.198	0.646	0.664	0.384	0.343	0.542	0.489	0.633	0.754	0.299	0.344	0.478	0.453	**0.475**
DHFt-2-5	0.532	0.519	0.266	0.219	0.323	0.415	0.425	0.450	0.633	0.754	0.613	0.654	0.233	0.272	0.422	0.463	**0.450**
Mean	**0.557**	**0.412**	**0.456**	**0.321**	**0.452**	**0.445**	**0.448**	**0.460**	**0.425**	**0.445**	**0.587**	**0.669**	**0.314**	**0.462**	**0.502**	**0.480**	

Table 6

	S. Em±	CD at 1%
Genotype	0.003	0.008
Treatment	0.004	0.011
Interaction	0.011	0.032